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ENHANCING SOIL CONSERVATION PRACTICE ADOPTION WITH TARGETED EDUCATIONAL PROGRAMS

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ABSTRACT

Two independent, but closely related, grant funded educational programs were developed and implemented to reduce soil erosion in selected areas of eastern Nebraska. Traditional extension programming methods as well as other more non-traditional approaches were used extensively to enhance soil conservation practice adoption. In one program, encompassing 220 000 ha (540,000 acre) of cropland, annual soil erosion was reduced by 2.3 million t (2.5 million ton) and annual fuel savings of 1.5 million L (390,000 gal) were achieved through a reduction in the number of tillage operations. In the second project, more than 93 000 m (305,000 ft) of terraces were constructed, which resulted in an annual soil erosion reduction of 151 000 t (166,000 ton). These projects demonstrated that targeted conservation programs can be very effective.
KEYWORDS. Erosion, Conservation, Education, Conservation tillage.

INTRODUCTION

Soil erosion and subsequent sedimentation have been identified as major water quality problems by the Nebraska Natural Resources Commission (1979). Eastern Nebraska, especially the northeastern portion, has a history of severe soil erosion due in part to a predominance of steep slopes and highly erodible soils. Some fields have annual soil erosion rates exceeding 225 t/ ha (100 ton/acre). In a study on a silt loam soil with a 10% slope, measured soil losses were nearly 55 t/ ha (25 ton/acre) from 64 mm (2.5 in.) of simulated rainfall applied over a one hour period (Dickey et al., 1984). As a means of comparison, the average annual allowable soil loss (T value) is 11.2 t/ ha (5 ton/acre) for this soil. While loss of topsoil is critical, erosion also results in the removal of fertilizers and pesticides, thus potentially contributing to water quality degradation.

Land in grain production in eastern Nebraska increased in the 1970s and early 1980s as pastures were converted to row crops. The Nebraska Crop and Livestock Reporting Service (1983) indicated that the primary row crops in this area, with a combined production area exceeding 3.2 million ha (7.9 million acre), were corn, soybeans, and grain sorghum. Soybeans, comprising one-quarter of this cropland, can contribute to the erosion problem in two ways. Generally, soybeans are planted into a well-tilled seedbed that leaves an unprotected soil surface susceptible to erosion. Additionally, soybeans do not produce much residue and they leave a loose, mellow soil surface condition that increases the erosion potential in the following year. Measured erosion following soybeans, in some cases, has been 350% greater than the erosion following corn for identical tillage systems (Dickey et al., 1985).

Conservation practices, both structural and non-structural, can be used to reduce soil losses to acceptable levels. However, adoption of many erosion control practices in eastern Nebraska has been slow. Such is the case with conservation tillage, one of the most effective and least expensive methods of reducing soil erosion.

The term "conservation tillage" includes all tillage and planting systems that leave at least 30% of the soil surface covered with crop residues after planting (Conservation Tillage Information Center (CTIC), 1985). Residue protects the soil from raindrop impact and reduces the movement of soil particles by runoff water. Research has shown that a minimum residue cover of 20% can reduce erosion by 50% of that which would occur from a conventionally tilled field with no surface residue (Dickey et al., 1984; 1985).

Deterrents to the adoption of conservation tillage include tradition, attitude and lack of understanding. While soil erosion has occurred, farmers generally have not seen corresponding productivity losses. In some cases, potential losses have been masked by inputs of fertilizer, improved hybrids, and irrigation. Even though soil erosion is a major problem, farmer concerns about possible yield decreases, weed control, fertilizer requirements, and soil suitability have delayed widespread implementation of conservation tillage.

Such attitudes are not changed easily. Adoption of conservation tillage, like other new technologies, follows a complicated and time-consuming decision process (Nowak, 1983). The adoption process requires:

- Awareness of either a problem or new technology.
- Recognition of the problem's cause and the individual's ability to change the situation.
- Technical and economic information, assistance and support for making the change. Well-defined information that addresses specific farmer needs is essential at every step of the adoption process.

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Conservation tillage systems alone can reduce soil losses to acceptable levels on many fields in Nebraska. However, on steeper slopes, residue amounts greater than 30% may be required. Further, some fields will need additional conservation practices such as terraces, grassed waterways, contour farming, and other proven practices to achieve adequate soil erosion control.

Removal of existing conservation structures in some areas of Nebraska, and a resistance to construction of new erosion control structures in other areas, also has been a problem. Some reasons given for this trend include an inability to utilize large equipment, maintenance requirements, land taken out of production, decreased field efficiency for certain field operations, and cost. However, a well-designed conservation plan can eliminate many of these concerns.

Educational Programs

To enhance the adoption of soil conservation practices in eastern Nebraska, two University of Nebraska Cooperative Extension educational programs were developed and implemented. The first program, initiated late in 1983, was the Agricultural Energy Conservation Project (AECP). Funding of over $1 million was acquired from the State of Nebraska (energy overcharge funds) and the University of Nebraska Foundation for this five-year program, which had overall goals to reduce energy requirements while conserving soil and water resources. This project had three distinct and equally funded portions: conservation tillage, ecofallow, and irrigation water management. Conservation tillage, focused in eastern Nebraska, is the only portion of the AECP discussed in this article.

An important and somewhat unique aspect of the AECP was the selection or targeting of high priority areas to receive concentrated educational programming efforts. Three specific target areas, encompassing portions or all of seven eastern Nebraska counties and totalling about 220 000 ha (540,000 acre) of row crop land, were selected for the conservation tillage component of the AECP. Criteria for selection of these target areas included: estimated soil erosion losses; farmer use and interest in conservation tillage; and the extension agents' desires to make conservation tillage a major educational thrust within their county programs. The second educational program, initiated in early 1985, was the Logan Creek Special Study (LCSS). Funded at about $50,000 annually by the USDA-Soil Conservation Service in Nebraska, this project consisted of a single target area encompassing about 20 000 ha (50,000 acre) in portions of three northeast Nebraska counties. The LCSS target area was chosen from several areas considered by personnel from the Soil Conservation Service (SCS), Agricultural Stabilization and Conservation Service (ASCS), Cooperative Extension (CE), Natural Resources Districts (NRD), and other agencies actively involved in soil conservation programs. Unlike the AECP, the LCSS had targeted cost-share funds for structural practices. However, these special funds were available for only one year.

The Logan Creek area is characterized by steep, irregular hills with short slope lengths. Conservation land treatment has not been readily accepted in the area as evidenced by the fact that less than 15% of the cropland area had adequate erosion protection at the outset of the project (LCSS, 1986). The average annual sheet and rill erosion within the LCSS area was over 635 000 t (700,000 ton) or approximately 32 t/ ha (14 ton/acre).

Overall Objective and Specific Goals

The overall objective of these two educational programs was to reduce soil erosion through the adoption of conservation practices. Specific goals to be attained within the target areas for the conservation tillage component of the AECP were to:

1. Increase the use of conservation tillage by 20%.
2. Increase the use of no-till planting by 10%.

Specific target area goals for the five-year LCSS included the same goals as the AECP, plus three additional goals:

1. Increase the area protected by conservation structures by 10%.
2. Increase the number of total farm conservation plans by 10%.
3. Reduce overall soil erosion by 20%.

Methods

While traditional extension programming methods (meetings, field demonstrations, demonstration plots, media releases, etc.) were used extensively in these two projects, various non-traditional approaches also were employed including:

Specific priority areas of the state were targeted for concentrated programming efforts.

Extension assistants were employed to carry out day-to-day project activities and work closely with farmers and others in the target areas.

Local guidance committees were developed and used to help define the educational needs and appropriate methods to meet those needs.

Surveys were conducted early in the projects to evaluate the existing use of conservation practices and farmer perceptions relating to conservation tillage.

Field measurements of residue cover remaining after planting were taken and correlated with the survey data.

A rainfall simulator was used to demonstrate the effectiveness of residue cover in reducing soil erosion.

In the LCSS, a quarterly newsletter was developed and mailed to landowners and operators in the target area.

Extension Assistants

Three extension assistants were employed to work in the four targeted areas. Two of these assistants were assigned to the AECP and one to the LCSS. Job responsibilities were to conduct day-to-day project activities, develop and coordinate educational activities in the target areas, and work directly with producers, implement dealers, chemical company representatives, as well as governmental and other agency personnel. The assistants also provided direct support to farmers needing equipment modifications or adjustments and other technical help when adopting conservation tillage systems. Minimum requirements for these positions were a bachelor of science degree in an agriculture-related field, work experience in conservation tillage, and a familiarity with conducting educational programs. Extension specialists from a broad range of disciplines, extension agents in the target areas, and the project leaders provided additional programming support.

Local Guidance Committees

Local committees were formed to provide guidance in defining educational needs and what educational methods would be best suited for their respective target area. Committee membership included farmers, agribusiness representatives, and personnel from the local NRD, SCS, and CE offices. Educational programs were then tailored to meet specific needs within each target area, and modified as the needs and conditions changed, to better enhance the adoption of conservation practices.

During the organizational meeting of each guidance committee, some additional people, such as local media representatives, were included to help ensure success. In two of the target areas, a special effort was made to involve farmers who were not using conservation tillage. The contributions and ideas from these farmers proved to be very valuable, as educational activities were better designed to overcome concerns and myths often expressed by non-users.

Documentation of Existing Conservation Practices and Perceptions

Early in both projects, information was collected to evaluate farmer perceptions regarding conservation tillage and the existing use of conservation practices. Mail surveys, field residue measurements, and personal visits were used to gather this preliminary information.

The mail survey questionnaire for the AECP was sent to 229 randomly selected farmers in the three target areas, and had a return rate of 56%. For the LCSS, a survey questionnaire was sent to all farm owners and operators in the target area. Of the 347 forms sent, 55% were returned.

Results from the AECP mail survey indicated that over 50% of the respondents felt they were presently using conservation tillage (Dickey et al., 1987). The survey information showed a substantial decrease in the use of the moldboard plow between 1974 and 1984, and a corresponding increase in the use of a chisel plow or disk as the primary tillage implement. This indicated a possible misconception that not using the moldboard plow was equivalent to practicing conservation tillage. Respondents also indicated concerns about the cost and effectiveness of herbicide programs, and the cost and performance of conservation tillage equipment, especially planters when operating in residue covered fields. These concerns helped direct some of the subsequent educational activities.

In addition to the mail survey, field measurements were taken to determine the residue cover remaining after planting. Measurements were taken on one field from each of 294 randomly selected farmers within the three AECP target areas, representing about 9% of the row crop producers. Fields from 27 farmers, representing 15% of the total cropland in the LCSS area were sampled. When the field measurements of residue were taken, a short, informal interview was conducted to obtain field information to estimate soil erosion losses, and to determine specific field operations used prior to planting the most recent row crop. A relatively large number of tillage operations (as many as 10) was reported by some of the farmers, which further indicated that not using the moldboard plow was equated to practicing conservation tillage.

Field residue measurements indicated that less than 5% of the fields surveyed had residue covers exceeding 30% (Dickey et al., 1987), the residue level used by the SCS and CTIC to define conservation tillage. These measurements, together with the interview information, verified that the perception between practicing conservation tillage and not moldboard plowing truly existed. Educational programs were therefore developed to emphasize that residue cover, rather than the choice of tillage implement, was the most important factor in reducing soil erosion.

Educational Activities

Guidance from the local committees as well as information gained from the surveys were used to develop specific educational programs. There were, however, several similarities among the recommendations from the local committees. For example, field demonstrations, plot comparisons, and informational meetings were recommended in each target area. Other types of educational activities included radio and print media, tours for agribusiness representatives, and a quarterly newsletter. Details of various activities follow:

Field Days. Over 40 field days having a total attendance of approximately 2,000 were held in the four target areas during a five year period. Often, two or three planters operating in no-till, ridge-plant, or tilled conditions where appreciable residue amounts remained were demonstrated. Time was available for farmers to ask technical questions of either extension personnel or cooperating implement dealers. Variations of these field days included demonstrations of no-till drills, no-till and ridge-till cultivators, and other conservation tillage equipment. In the LCSS, demonstrations of terrace layout and construction also were conducted.

Often these field days also included tours of tillage plots in the immediate area. Refreshments were usually provided by local implement dealers, chemical company representatives, or financial institutions .

Rainfall Simulator. To vividly demonstrate the effectiveness of residue cover in reducing erosion, a rotating boom rainfall simulator was often used in the field demonstrations, figure 1. The simulator, which has also been used extensively in Nebraska erosion research (Dickey et al., 1984 and 1985; Jasa et al., 1986; Shelton et al., 1986), applied water at a rate of approximately 64 mm/h (2.5 in./ h), giving a rainfall erosion index (EI) typical of a single storm event expected to occur once every two years in eastern Nebraska (Wischmeier and Smith, 1978).

In preparation for the demonstration, an area was uniformly tilled to eliminate most of the existing surface residue cover. Within the tilled area on each side of the simulator, two side-by-side plot areas, each approximately 9 m (30 ft) long and 1.5 m (5 ft) wide, were established using metal borders. Residue (often small grain straw) was then added to the surface of three plots, resulting in four degrees of residue cover, typically 0 to 5% (cleanly tilled), 90 to 100% (representing no-till), and 25 and 50% (representing varying amounts of tillage). As rainfall was applied, runoff water passed through flumes where field day participants could visually compare differences in both

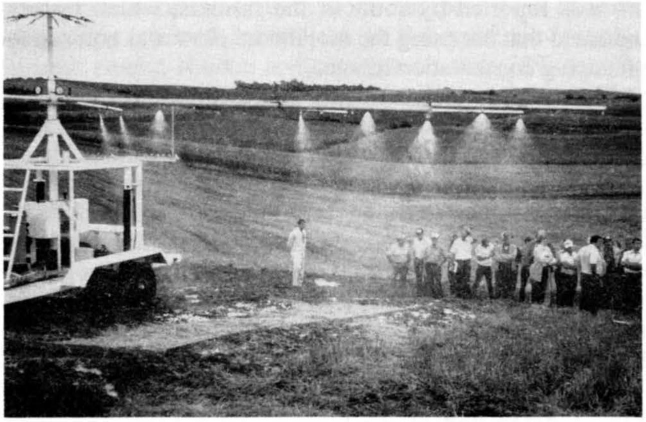

Figure 1–Rotating boom rainfall simulator used in the field demonstrations.

soil erosion and water runoff, figure 2. While originally designed as a research tool, the rainfall simulator proved to be a very effective educational tool as well. Dillaha et al. (1988) made a similar observation when demonstrating the effectiveness of best management practices in Virginia.

Demonstration Plot Comparisons. The guidance committees strongly encouraged the development of demonstration plots to show different aspects of conservation tillage. These plots included: side-by-side comparisons of no-till planting and the farmer's conventional tillage and planting system; various fertilizer application methods; and different herbicide combinations. Whole fields of no-till or ridge-plant were sometimes used since some of the local committees felt that anything could be made to work on smaller plot areas, but to make much impact, field sized areas would be necessary. The plots or fields were planted and tilled as appropriate by the cooperating farmer, usually using his equipment. The extension assistants generally helped with necessary equipment adjustments, herbicide recommendations, and plot layout.

Many of the plots were included on tours or field days. As part of the tour, the cooperating farmer told what tillage and planting system was used, the herbicide program, and the solution to any problems encountered. Sometimes the farmer displayed the planter or other appropriate piece of conservation tillage equipment that was used.

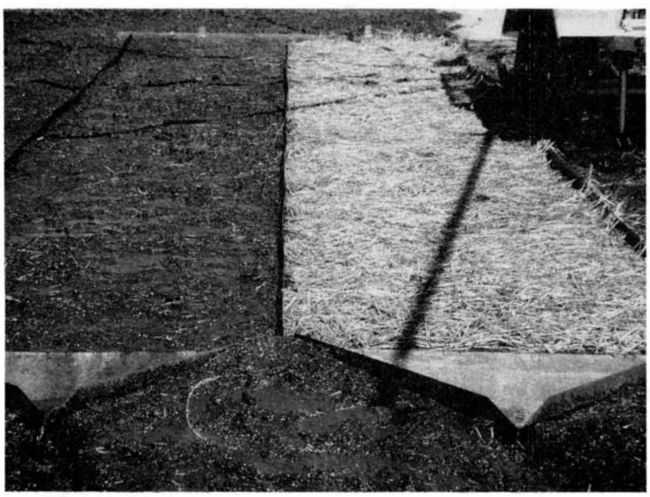

Figure 2–Soil erosion demonstration plots used in conjunction with the rainfall simulator.

Crop Yield and Costs. Yield and cost data were obtained from the plots with side-by-side comparisons of different tillage and planting systems. These data were then incorporated into local meetings as part of the educational program. Thus, farmers in the area were able to see no-till planting equipment in use, could follow the growth of the crop, and had an opportunity to learn what the yield and production costs were.

These data provided evidence to dispel the perception that no-till planting results in reduced yields and increased costs. For example, the 1984 through 1988 results showed that for corn production, no-till planting had a crop yield that was equal to or greater than the conventionally planted systems at 28 of the 35 comparison sites. No-till was also at least \$12/ ha (\$5/acre) less expensive in 25 of the 35 comparisons, and had the same cost in four comparisons. Similarly, there were 18 sites of no-till planted soybeans compared to a conventional or reduced tillage system during the same period. In 17 comparisons, no-till soybeans had the same or better yield than the tilled system. The no-till soybean fields were at least \$12/ha (\$5/acre) less expensive for 7 of the 18 comparisons, and had the same cost for eight comparisons (Jasa and Biere, 1989).

Identification Signs. Signs, which included the cooperator's name and a project logo, were placed adjacent to the demonstration fields or plots, figure 3. These signs, which remained in place during the entire growing season, provided additional project identity and visibility. In the LCSS, large signs, approximately 1.2 m × 2.4 m (4 ft × 8 ft), also were placed along the major highways that entered the designated target area, figure 4.

Meetings. Meetings were developed and used in the target areas. One type was a full day, in-depth, conservation tillage meeting. Extension specialists representing a broad spectrum of disciplines presented most of the program. Printed proceedings, with articles devoted to each topic presented, as well as many other articles pertaining to conservation tillage, were distributed to meeting participants as part of the registration fee. Farmers from the local area also presented information, in a panel format, about their specific conservation tillage system. Often these farmers were the same ones that had hosted a field day or demonstration plot tour. The extension assistants often helped the farmer prepare visual aids. The farmer presentations were well received by meeting attendees, with meeting evaluations often indicating that this aspect of the program should be expanded.

At these in-depth meetings, evaluation forms were used to provide additional guidance for the overall educational program. These forms also inquired about plans to adopt or change tillage practices. Averaged across five years, 80% of the farmers filling out a questionnaire indicated they would be changing their tillage programs as a result of the information presented during the meeting. The range in response to this question was from 75% in 1984 to 84% in 1986. About 55% of the 1988 meeting attendees indicated that they had not previously attended a similar conservation tillage meeting.

The second type of meeting used was in a local, small group setting termed a "coffee shop" meeting. These were

Figure 3–Demonstration plot identification sign used in the Ag Energy Conservation Project.

very informal. Generally, the extension agent in the area and the extension assistants answered questions that farmers had regarding conservation tillage. Attendance was usually less than 20 people, but the discussion and interaction that occurred was of tremendous help to those farmers just getting started with conservation tillage, or those with quite specific questions. This type of meeting also was used in the LCSS, in conjunction with SCS, ASCS, and NRD personnel, to explain provisions of the 1985 Food Security Act (Farm Bill), and to provide information regarding the development of farm conservation plans.

Two other meeting formats included both sprayer and planter clinics. These generally involved calibration or adjustment of farmer owned equipment and were often conducted in farmer owned shops. The planter clinics were also conducted at local equipment dealer facilities.

Media. News releases and factsheets were used frequently as a means of increasing awareness and providing education. Many of the farmers having tillage plots were the subject of news releases prepared by the extension assistants. The factsheets, brief and to the point, were written in response to some of the most commonly asked questions. Radio tapes also were used to promote upcoming events and provide timely information to area producers.

Newsletters. In the LCSS, a quarterly newsletter entitled "Focus on Conservation" also was developed as an educational tool. The newsletter, which was typeset, printed on high quality paper, and included photographs, was mailed to all landowners and farm operators in the target area, providing timely advice and keeping clients advised on progress being made, upcoming activities, and governmental program requirements and deadlines.

Accomplishments

The AECP was completed in June 1989. To evaluate the project impact, a second field survey of 304 randomly selected fields was conducted. The information obtained was similar to that obtained in the 1984 survey. Using this information and the Universal Soil Loss Equation (Wischmeier and Smith, 1978), the average annual soil loss from the 294 randomly selected fields in 1984 was 48.3 t/ha (21.6 ton/acre), whereas the average annual soil loss from the 304 randomly selected fields in 1988 was 38.1 t/ha (17 ton/acre). Since the AECP target encompassed a row crop area of 220 000 ha (540,000 acre), the annual erosion reduction in the target area was 2.2 million t (2.5 million ton). This was achieved because the number of tillage operations was reduced between 1984 and 1988. There was also about a three fold increase in the use of no-till planting, from 1.7% in 1984 to 6.6% in 1988. Statewide, no-till use was 2.9% and 4.0% in 1984 and 1988, respectively (CTIC, 1985 and 1988). During the same period, conservation tillage use increased by 21.4% in the AECP target areas; whereas, there was a statewide decrease of 7.1% (CTIC, 1985 and 1988). The most common change in 1988 was no-till planting of corn into soybean residue, rather than the previously used system having at least two tillage operations.

The reduction in the number of tillage operations also reduced the amount of fuel and labor required. Using the stated field operations performed on each field, and the fuel requirements for each operation given by Shelton et al. (1979), the average fuel use on the fields surveyed in 1984 was 30.8 L/ha (3.3 gal/acre), whereas the 1988 fuel use was 24.3 L/ha (2.6 gal/acre), for an average annual savings of 6.6 L/ha (0.7 gal/acre). For the AECP target area, annual fuel savings amounted to 1.5 million L (390,000 gal). Similarly, annual labor savings because of the reduced number of tillage operations were 60 000 h. Assuming \$0.24/ L (\$0.90/gal) and \$6.00/ h, the annual fuel and labor savings was about \$711,000.

The LCSS had a tremendous impact on terrace construction. Through a combined effort of the Lower Elkhorn NRD and the ASCS, 90% cost-sharing was available for structural practices completed in the target area during a one-year period ending 30 September 1986. For the other years, cost sharing was about 65%, typical for the remainder of the state. Because of this level of cost

Figure 4–Road sign used to identify the Logan Creek Special Study target area.

sharing and cooperative efforts among the SCS, CE, ASCS, and NRD, 61 cooperators installed some form of conservation structure. Specifically, a total of 93 000 m (305,000 ft) of terraces having 38 000 m (125,000 ft) of underground outlets were installed with about 87% of these being constructed with the 90% cost sharing. These structures benefitted over 2 300 ha (5,700 acre) of cropland, or slightly over 11% of the target area. The estimated annual soil erosion from this land was reduced from 640 000 to 489 000 t (706,000 to 540,000 ton), an annual savings of 151 000 t (166,000 ton), or 24%, with the construction of these terraces.

Conservation tillage use increased in the LCSS. In 1986, the average residue cover for the 42 fields sampled was 9.2% after tillage and planting. None of the fields had a 30% or greater cover and only one field was no-tilled.

In 1989, the average residue cover for the 73 fields sampled was 15.6%, nearly twice as much cover remaining as in 1986. Additionally, 12% of the fields sampled in 1989 had a 30% or greater cover and no-till was used on 16 fields. The ten-fold increase in no-till combined with the increased residue cover resulted in an annual soil savings of 122 000 t (135,000 ton), a 19% decrease in the study period.

Although the total impacts of both projects cannot be fully evaluated since changes in conservation practices will reap benefits for many years, specific project goals were met or exceeded. Most importantly, the projects have shown that targeted conservation educational programs and targeted cost-share funds can have substantial impacts in a short amount of time.

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